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XII. *An anatomical Account of the Squalus maximus (of Linnaeus), which in the Structure of its Stomach forms an intermediate Link in the Gradation of Animals between the Whale Tribe and cartilaginous Fishes.* By Everard Home, Esq. F. R. S.

Read May 11, 1809.

THE fish from which the following account is taken, was entangled in the herring nets belonging to the fishermen of Hastings, off that coast, and about half-way across the Channel, on the night of the 13th of November, 1808. It was brought ashore at Hastings on the following day, and my late worthy friend, Lieut. Col. BOTHWELL, who was on the spot, purchased it on my account. On the 17th, Mr. CLIFT, the Conservator of the Hunterian Museum, at my desire, went to Hastings, and after making a drawing of the fish, examined its internal structure, and brought to London such parts as were most particularly deserving of notice.

The fish is a male, thirty feet six inches long from the anterior part of the head, to the longest extremity of the tail, and about nine feet from the extreme point of the dorsal fin to the middle line of the belly.

The skin is of a dirty blue, or light slate colour; as rough as a new file in the direction from the tail to the head, but having a satiny feel in the opposite direction. On the belly the skin is white, thick, and very strong.

The mouth is about five feet from one angle to the other, There are six rows of teeth towards the middle of each side

of the jaw; but in the other parts they are less numerous. The teeth are small, round, conical, very pointed, and bent a little inwards.

The nostrils open on the edge of the upper lip. The eyes are very small, and the pupils perfectly round.

Half-way between the eye and the gills, on each side, is the orifice of a canal, which leads into the mouth.

The gills are five in number on each side.

The pectoral fins are situated a little behind the posterior gills.

The dorsal fin is situated nearly opposite to the middle space, between the pectoral and anal fins. The posterior dorsal fin is small, and situated half-way between the anal fins, and the setting on of the tail. The two anal fins are attached on their upper edge for about half their extent each to the lower side of a long projecting body peculiar to the male. All the fins have a thick round edge anteriorly, and become gradually thinner towards the posterior part, which is partially serrated.

The projecting bodies on the sides of the anus I shall call holders, as they are employed in grasping the female in the time of copulation. They are rounded on their lower surface: the skin covering them is uncommonly thin and smooth: on their upper surface, it has a gloss like that of silk, and there is a deep sulcus, in which is contained a strong, flat, sharp, bony process, five inches long, which moves on a joint, and the bone projects an inch and a half beyond the skin, like a spur.*

There is a deep sulcus at the setting on of the tail, as if a

* I shall give a particular description of these holders in a future paper on the generation of the dog-fish.

rope had been tied tight round that part, and on each side of the fish, there is a scabrous ridge extending from this sulcus as far forwards as the posterior dorsal fin. The tail may be said to begin from this deep transverse sulcus; it is vertical; the upper portion is longest and narrowest. The thin edge of the tail has a jagged appearance, as if formerly wounded by the bites of small fishes.

The proportions of these parts to each other will be seen in the annexed figure.

In this fish no part of the skeleton can be said to be perfectly formed bone, although the skull, which defends the brain, the upper and under jaws, and the vertebræ, contain bony matter; the vertebræ however in much the smallest proportion.

The skull has no cartilaginous attachment to the upper jaw, so that it is readily separated from it, while the jaws themselves are strongly connected by means of the joint between them. The skull, when the jaws are removed, is very small, being adapted to the size of the brain, which in this fish bears a very small proportion to that of the whale tribe.

The vertebræ next the head are rather smaller than those a little further on. The largest are seven inches in diameter, the cavities between them containing about three pints of fluid. A particular account of the intervertebral joint in this fish has been already laid before the Society.

On the posterior part of the vertebræ, there is a sulcus, in which a strong elastic ligament passes from the head almost to the tail. The canal for the spinal marrow is very small; and on the anterior part of the vertebræ, below the anus, there is a canal, in which is contained the aorta.

Each gill is supported on two cartilages, one long and flat connected with the spine, the other short ; there is a joint between them which admits of some degree of motion. There are cartilages which answer the same purpose, as the sternum and scapulæ of quadrupeds. Those resembling the scapulæ are connected to the spine, and to them the cartilages of the pectoral fins are articulated.

The broad part of the pectoral fin is formed of a number of cartilaginous finger-like processes. The terminations of which are inclosed between two sets of ligamentous fibres, that form the thin margin of the fin.

The other fins and tail are formed in the same manner, and are also connected with the spine.

There is an imperfectly formed pelvis, connected to the spine by strong ligaments and muscles. The cartilages of the holders are united to the pelvis ; they correspond in number and general appearance to a femur, tibia, and three toes. This part has been frequently mistaken by superficial observers for the leg and foot, to which it bears a very general resemblance.

The heart is not much larger than that of a bullock : the auricle is extremely thin in its coats. The valves at the origin of the pulmonary artery, are three in number ; besides which there are three sets of valves in the course of the artery, at a short distance from each other. Each set is composed of three valves. They are weaker than those at the origin of the artery, and they are attached by tendinous chords to the inside of that vessel.

The tongue is flat, and can hardly be said to have any part of it loose and pendulous.

The œsophagus is about a foot in length: its internal surface is milk white and polished, having a number of conical papillæ projecting into the canal. These become gradually longer towards the stomach; they all point downwards, and the lower ones have a fringed appearance, which is shewn in the figure.

The stomach, from its weight, could not be removed till emptied of its contents, which consisted of several pails full of pebbles, a quantity of mucus, and a small portion of a substance, which proves to be the spawn of a univalve. The appearance of the internal structure of the stomach, and the dimensions of its different parts are shewn in the drawing. Besides the cardiac and pyloric portions, as in other sharks, there is a globular cavity, with which the pyloric portion communicates by a very small orifice, and there is another orifice nearly of the same size, between this cavity and the intestine. The upper part of the duodenum is smooth, and the gall ducts open into it by a long nipple-like projection, and just below this the spiral valve has its origin, as in other sharks.

The valvular intestine, from the closeness of the turns of the valvular part, is so firm and compact, that when placed on its end, it stood upright like a cask. It is about four feet long, and ten inches in diameter, terminating at its lower end in the appearance of a rose, which is so remarkable, that it is represented in the annexed figure. Below this the rectum begins, which in this instance was two feet long. Behind the rectum, and loosely attached to the spine, is an oval bag, the coats of which are very strong: its internal membrane is reticulated, forming very deep folds, and there is a long narrow duct leading from its cavity into the rectum. This bladder

contains a dark-coloured glary fluid, and this is common to the shark tribe, but the use of such a secretion is not at present known.

The spleen in all respects resembles that of the blue shark formerly described.

The pancreas is situated in the angle between the pylorus and duodenum. It was so much broken, that its shape could not be ascertained; but its substance is composed of a soft whitish mass, intermixed with roundish bodies of a firmer texture.

The liver consists of two lobes nearly equal in size. They occupy the anterior part of the belly, from below the gills to the rectum. It yielded about three hogsheads of oil. No gall-bladder was discovered; and as a chord (like a navel string) consisting of twelve hepatic ducts passed from the liver to the duodenum, there is reason to believe that this fish has no gall-bladder. There is none in the piked whale. On cutting into the liver, the blood-vessels were found to be so large, that they readily admitted a man's arm, and on pulling them the substance of the liver was readily torn in the direction of the smaller branches, which went off at right angles to the central trunk, as regularly as those of the gills.

The kidneys are long narrow bodies, lying on each side of the spine, and extending along the whole length of the abdomen. The ureters run along their inner edge, and terminate in an oval cavity just within the verge of the anus, which has an imperfect septum separating it into two parts, the ureters opening on the opposite sides of this septum, this cavity must therefore be considered as the urinary bladder.

The testicles are situated immediately behind the origin of

the two lobes of the liver. They are oval, flattened, pulpy bodies. The epididymis nearly surrounds the testicle, and then forms the *vas deferens*, which makes many close turns upon itself, and passes downwards, adhering to the anterior surface of the kidney, in which it is in some measure embedded: the lowest part of the *vas deferens*, for three feet in length, becomes very large, and has no convolutions. The *vasa deferentia* contained a substance like thin starch, broken down into small rounded portions, mixed with a thinner fluid. These ducts were so large, as readily to allow a man's arm to be introduced up to the shoulder. Each *vas deferens* terminates by a small contracted orifice in the urinary bladder, one on each side, so that this bladder is both a reservoir for the urine and semen. The bladder in the male opens externally by an infundibular process, which constitutes the penis.

On each side of the anus, within its verge, near the root of the penis, is an oblique aperture, communicating freely with the cavity of the abdomen.

From the account which has been given, the *Squalus maximus* appears in many respects to be similar in its structure to the shark, but it differs essentially from it in the form of the stomach, and in that respect forms an intermediate link between the shark and whale. It probably lives on nearly the same kinds of food as the whale.

The sharks form a tribe of such extent, that from what we already know of their internal structure, they may be subdivided into many genera, making with the rays and scates, so many links between the whales and fishes, properly so called. The stomach and organs of generation are the parts in which the structures are most essentially different. In the

dog-fish, the stomach in its form is neither like that of the *Squalus maximus*, nor blue shark. I have given a drawing of it, as it appears to form a link between the two. The structure of the ovum, and the mode of hatching it is very different in the dog-fish from that of many other sharks; as I have had opportunities of investigating the mode of generation in that species, I shall make it the subject of a future communication.

I cannot close the present paper without mentioning, that nearly about the same period, two other *Squali* of large dimensions were thrown upon our coast. The probable cause of this event, is the season being uncommonly boisterous and tempestuous. On the 3d of January, 1809, a fish was thrown ashore at Penrhyn, in Cornwall. On hearing of it from a person on the spot, I sent down a drawing of the subject of this paper to compare with it, and the fish proves to be of the same species, and a male, measuring thirty-one feet in length.

The other was thrown ashore on the 7th of October, 1808, at Rothiesholm, an estate of GILBERT MEASON, Esq. in Stronsay, one of the Orkney isles. It had been seen lying on some sunken rocks, eleven days before, was in a half putrid state, and the sea fowl were in great numbers feeding upon it. Those who saw it, reported that the skin was rough in one direction, and smooth like satin in the other. At the time of its being examined, the skin and a great many other parts of the fish were wanting.

Mr. MEASON, with a zeal for science which does him infinite credit, upon hearing the strange accounts which were given of this sea monster, got his brother, MALCOLM LAING, Esq.

and Dr. GRANT, an eminent physician (both justices of the peace), to take depositions on the spot, from those persons who had seen the fish, that its real appearance might be ascertained. This examination, however, did not take place till six weeks after the fish was thrown ashore.

These depositions were sent to Sir JOSEPH BANKS, who put them into my hands.* I also received, a short time after, from my friend Mr. LAING, in consequence of a request I made for that purpose, that part of the skull, which contained the brain, the upper jaw having been separated from it, a considerable number of the vertebræ of the back united together by their natural attachments, a portion of one of the pectoral fins, with the cartilages that unite it to the spine, and a long and short cartilage forming the support of one of the gills. On comparing these different parts, with those of the *Squalus maximus*, they were found to agree, not only in their form, but also in their dimensions. This led to the opinion of the fish being a *Squalus*, a very different one from what was formed by those who saw it in the mutilated state in which it was thrown ashore, and who called it a *sea snake*. In the different depositions, several parts are accurately described, such as the valvular intestine, which was taken for the stomach, and the bristles of the mane, which are described as ligamentous fibres: one of them is in my possession, and is of the same kind with the fibres forming the margin of the fins of the *Squalus maximus*. The drawing that was made from memory, and which I have annexed, will enable me in a few words to point out how much, in some things, those who saw the fish adhered to

* The depositions are very long, and exceedingly minute; they are preserved in the Board-book of the Royal Society.

truth, and in others allowed their imaginations to supply deficiencies, for one of them declared, with confidence, that the drawing was so exact a representation of what he had seen, “that he fancied he saw the beast lying before him, at a distance, on the beach.”

The drawing is correct in the representation of the head and anterior part of the fish, from which the skin, the upper and lower jaw, the gills, and gullet, had been separated by putrefaction; and when we consider that the liver and the other viscera were all destroyed, except the valvular intestine, which was taken away by the observers, the size of the body that remained would be nearly in proportion with the drawing. The legs are tolerably exact representations of the holders in the male *Squalus maximus*, described in a former part of this paper, and therefore are not imaginary, only that four have been added which did not exist. This is satisfactorily determined by the pectoral fin, which is preserved, having no resemblance to them. The mane, they said, was composed of ligamentous fibres, one of which was sent to London; this corresponds, in its appearance, with the fibres that form the termination of the fins and tail of the *Squalus maximus*, such an appearance therefore was seen, but could only be met with in the place of the two dorsal fins, instead of being continued along the back, as in the drawing. The contortions towards the tail are such, as the intervertebral joints could not admit of, they are therefore imaginary.

It is said, two different persons measured the fish; one by fathoms, the other by a foot rule, and that it was fifty-five feet long. Their accuracy is at least doubtful, as the parts that are preserved correspond with those of a fish about

thirty feet long, and it is rendered still more so, as the person who gives the length in fathoms, says, he saw at that time the six legs, the two foremost being larger than the hinder ones, and the lower joint more rounded from the body to the toes. The pectoral fin, which is preserved, proves this declaration to be incorrect: the person who measured the fish with a foot rule, declares the length, from the hole in the head to the beginning of the mane, to be exactly fifteen feet, which is probably correct, since a *Squalus* of about thirty-six feet long would measure, from the fore part of the skull to the dorsal fin, about fifteen feet; but the other measurement must be questionable.

It is deserving of remark, that there is no one structure represented in this drawing, which was not actually seen. The skeleton of the holders corresponds with the legs in the drawing, the margin of the dorsal fin in a putrid state with the mane; so that the only errors are in the contortions towards the tail, the length of the fish, and the number of the holders, which were mistaken for legs:* and when we recollect that the drawing was made from memory six weeks after the fish had been seen by those, who describe it, during which interval it had been their principal subject of conversation, we may conclude that so extraordinary an object, as the mutilated fish must appear when believed to be a perfect one, would, in their different discourses, have every part exagge-

* This mistake of the holders of the male shark for legs, has been frequently made. There is a drawing in Sir JOSEPH BANKS's library, sent from Ireland, in which the fish is represented walking like a duck, with broad webbed feet. The skin of a male *Squalus maximus* was exhibited in London some years ago distended by means of hoops, and the holders were shown as its legs, on which it occasionally walked.

rated, and it is only remarkable that the depositions kept so close to the truth as they have done.

It is of importance to science, that it should be ascertained, that this fish is not a new animal unlike any of the ordinary productions of nature, and we are indebted to the zeal and liberality of Mr. MEASON and Mr. LAING, who have collected a sufficient body of evidence to enable me to determine that point, and prove it to be a *Squalus*, and the orifice behind the eye, which communicates with the mouth met with in the skull, renders it very probable that it is a *Squalus maximus*.

This opinion is further confirmed by the *Squalus maximus*, known by the name of the basking shark, being frequently seen upon the coast of Scotland.

That a fish so common in the northern seas, containing a large quantity of oil, should have been so rarely caught, and indeed that it should not, as well as the whale, become an object of the Greenland fishery, appears, on the first view, not easily accounted for; but Sir JOSEPH BANKS has thrown out a suggestion which satisfactorily explains it. The whale, when struck, descends towards the bottom of the sea, but is soon obliged to rise to the surface to breathe, which enables the fishermen to follow, and prevent the breaking of their line; but the *Squalus maximus*, as it breathes water, has no occasion to return to the surface, and will always carry off the line.

EXPLANATION OF THE PLATES.

PLATE VI.

Fig. 1. An engraving of the *Squalus maximus* caught at Hastings in 1808.

a. A projecting body peculiar to the male. There is a pair of these, by means of which the female is held in the act of copulation.

Fig. 2. An exact copy of the drawing sent up to Sir JOSEPH BANKS from the Orkneys, of a *Squalus* in a mutilated state, without the skin or viscera, thrown ashore upon that coast, which being mistaken for a perfect animal, unlike any thing at present known, it was supposed to be a sea snake.

a. The skull, from which the upper and lower jaw had been separated by putrefaction.

b. The orbit.

cc. The spine of the fish surrounded by muscles, the gills and gullet having been separated by putrefaction.

dd. The dorsal fin, which in a half putrid state puts on a shaggy appearance, the ligamentous fibres of which the broad part is composed being separated from one another; this was mistaken for a mane, and, from want of accurate observation, was continued on to the tail, although it could only be seen in the situation of the two dorsal fins.

ee, ee, ee. The holders of the male, which are represented with tolerable accuracy as they appear in a half putrid state, but two only are met with in nature in the situation in which they are seen in Fig. 1, there they have a different appearance, the internal parts being concealed by the common integuments.

fff. Contortions which the structure of the intervertebral substance of the fish rendered it impossible for the spine to make, and therefore could not have been seen. These contortions so represented, render it highly probable that the account of PONTOPPIDAN's sea snake had been read by the

spectators of this fish, in the interval of time between their seeing it and their depositions being taken.

PLATE VII.

The stomach of the *Squalus maximus* laid open to shew the appearance of its internal structure.

a. The internal membrane of the œsophagus exposed to view.

b. The termination of the œsophagus in the stomach by a loose kind of fringe.

cc. The cardiac portion of the stomach, the upper part of which is slightly honey-combed; the lower having more of a rugous, or plicated appearance.

dd. The pyloric portion, the coats of which are very strong, and the internal rugæ very thick. The opening at the pylorus is very small, as in the whale tribe.

ee. The external surface of the valvular intestine.

f. The ducts of the liver passing down in the form of a broad band to the duodenum.

ggg. The spleen.

PLATE VIII.

Fig. 1. Shews the internal surface of a small cavity interposed between the pyloric portion of the stomach and the intestine.

aa. The external surface of the pyloric portion of the stomach.

b. The cavity, with which it communicates, laid open, exposing the small opening between them, and another opening leading to the intestine.

c. The cavity of the intestine before the valvular structure begins.

d. The orifice leading into it from the cavity next the stomach.

e. The opening of the ducts from the liver.

f. The valvular portion of the intestine.

g. A portion of the spleen.

h h. The ducts passing from the liver.

Fig. 2. The termination of the valvular portion of the intestine in a rose-like form ; by means of this structure the aliment is prevented from too readily making its escape.

PLATE IX.

The stomach of the common dog-fish laid open, to shew the difference of its internal structure from that of the *Squalus maximus*, and also the difference between it and that of the common shark.

a. The internal membrane of the œsophagus.

b. The termination of the œsophagus.

c c. The cardiac portion of the stomach, the superior part of which is plicated, and the inferior slightly honey-combed, the very reverse of what is met with in the *Squalus maximus*.

d. The pyloric portion.

e. The pylorus,

f. A small space between the pylorus and the intestine, bearing a faint resemblance to the cavity in the *Squalus maximus*, but so slight, as only to be detected when the fish is in a very recent state.

g. The beginning of the intestine.

h. The valvular portion.

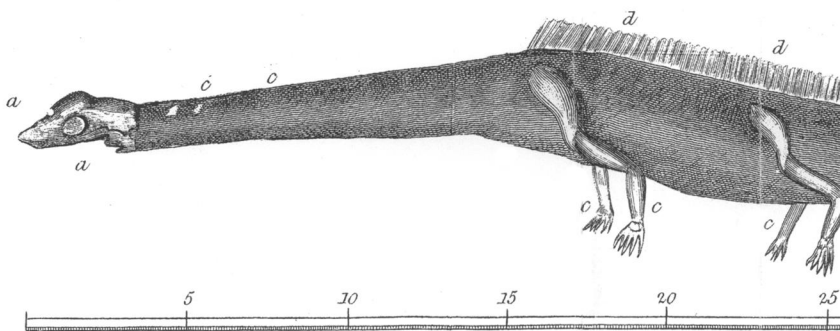
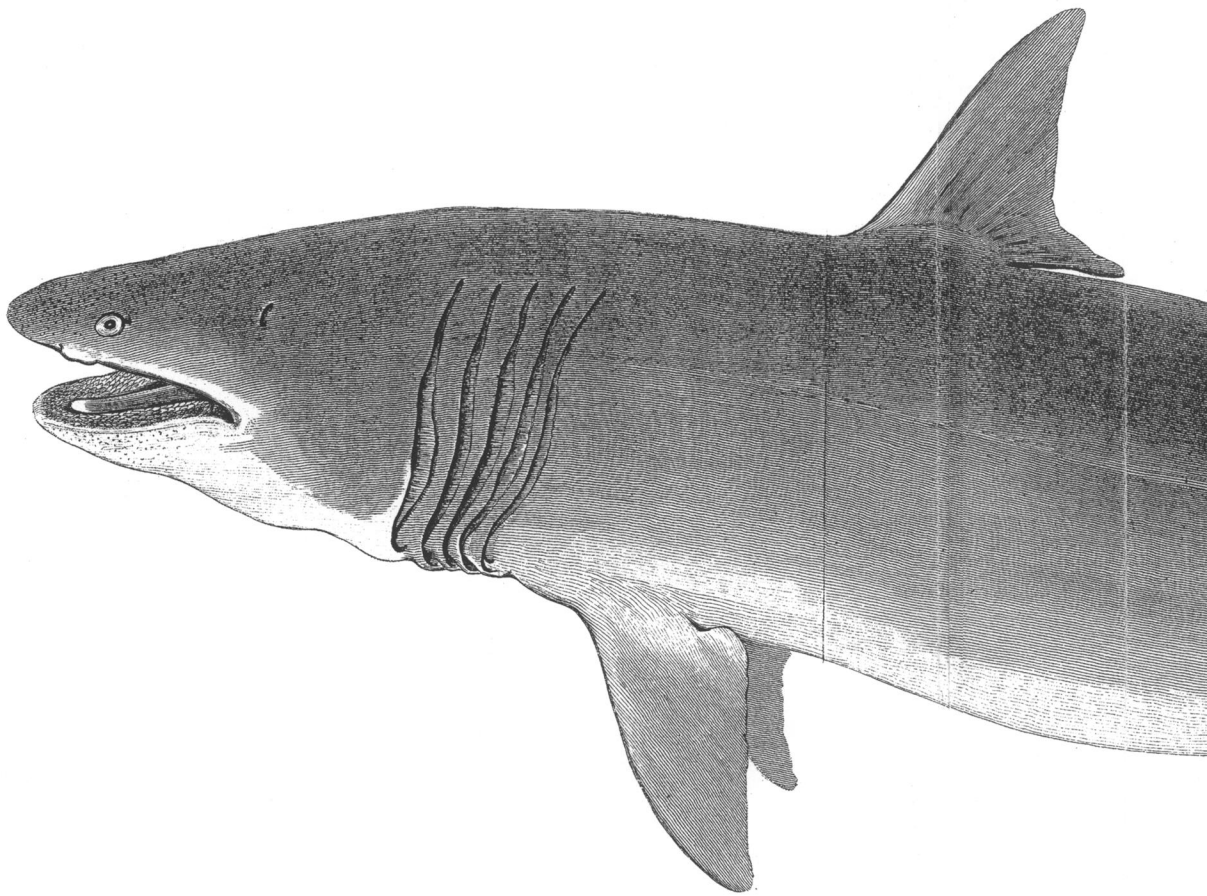


Fig. 1.

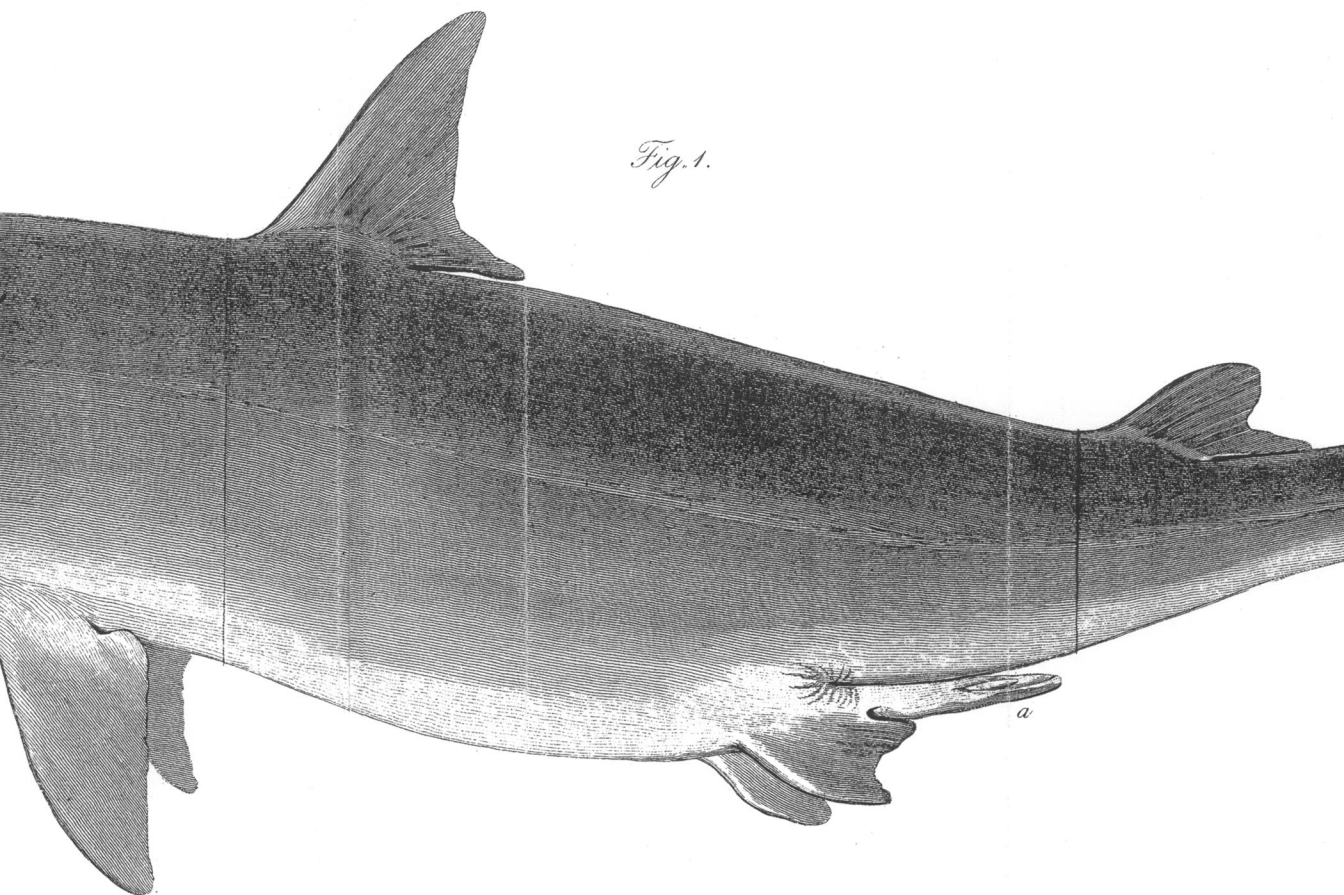
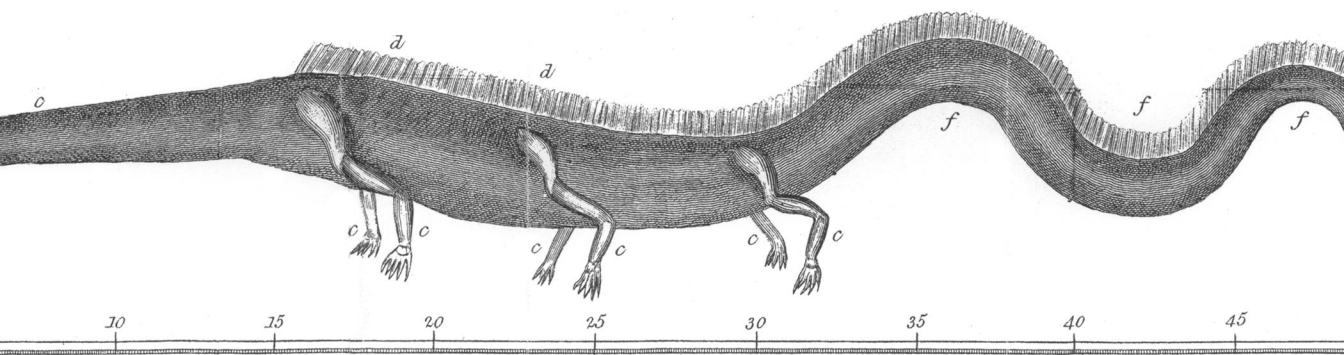
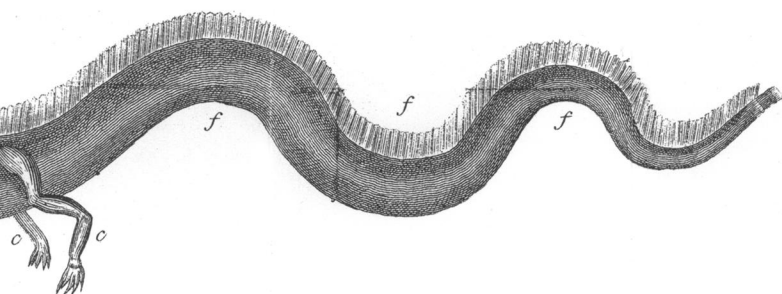
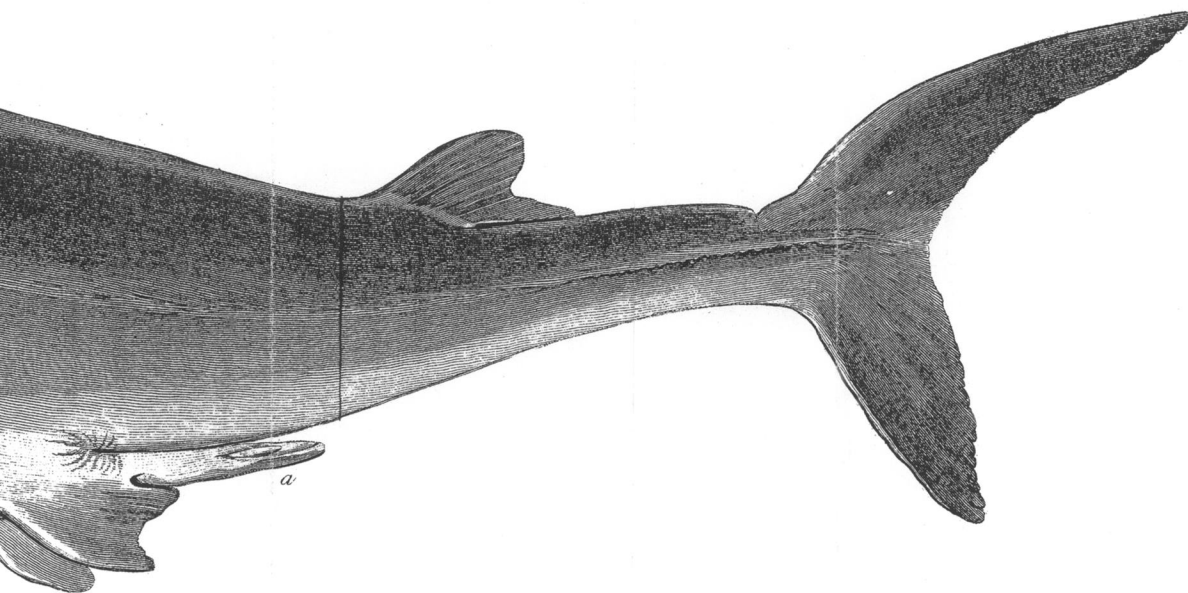


Fig. 2.



Scale Half an Inch to a Foot.



30 35 40 45 50 55 Feet.

Fig. 1.

2 Inches to a Foot.

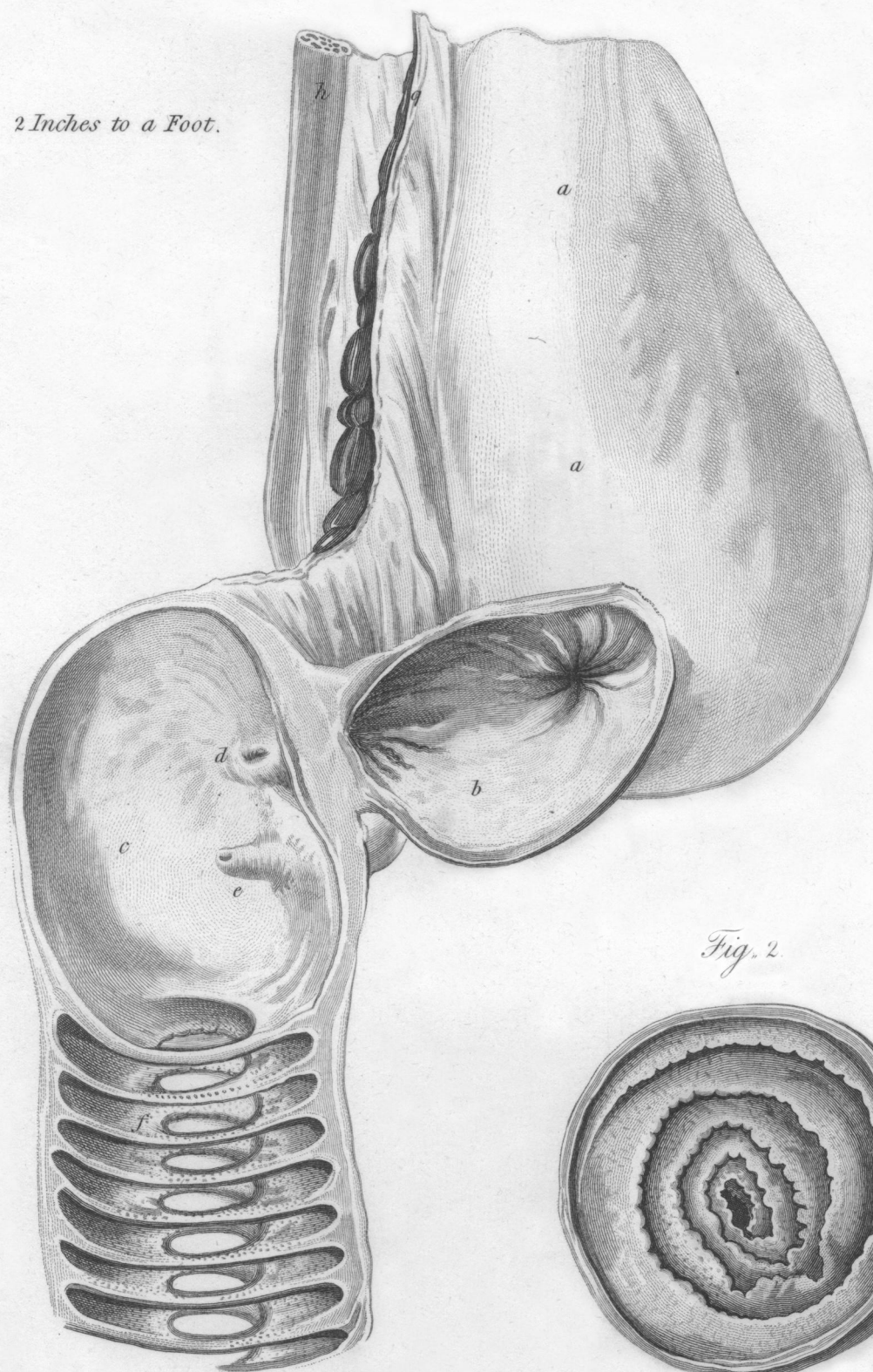
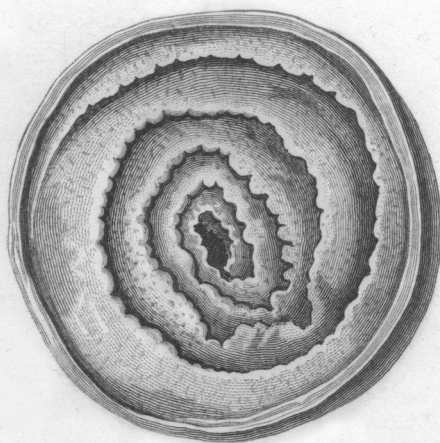
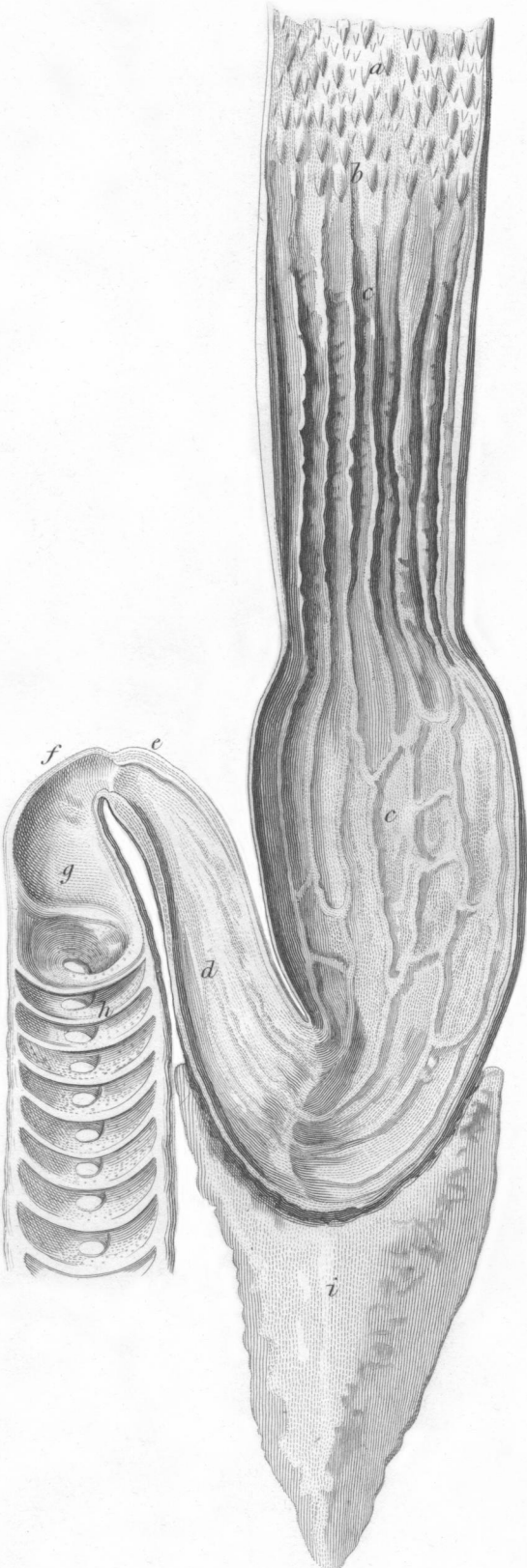


Fig. 2.





1 Inch to a Foot.

